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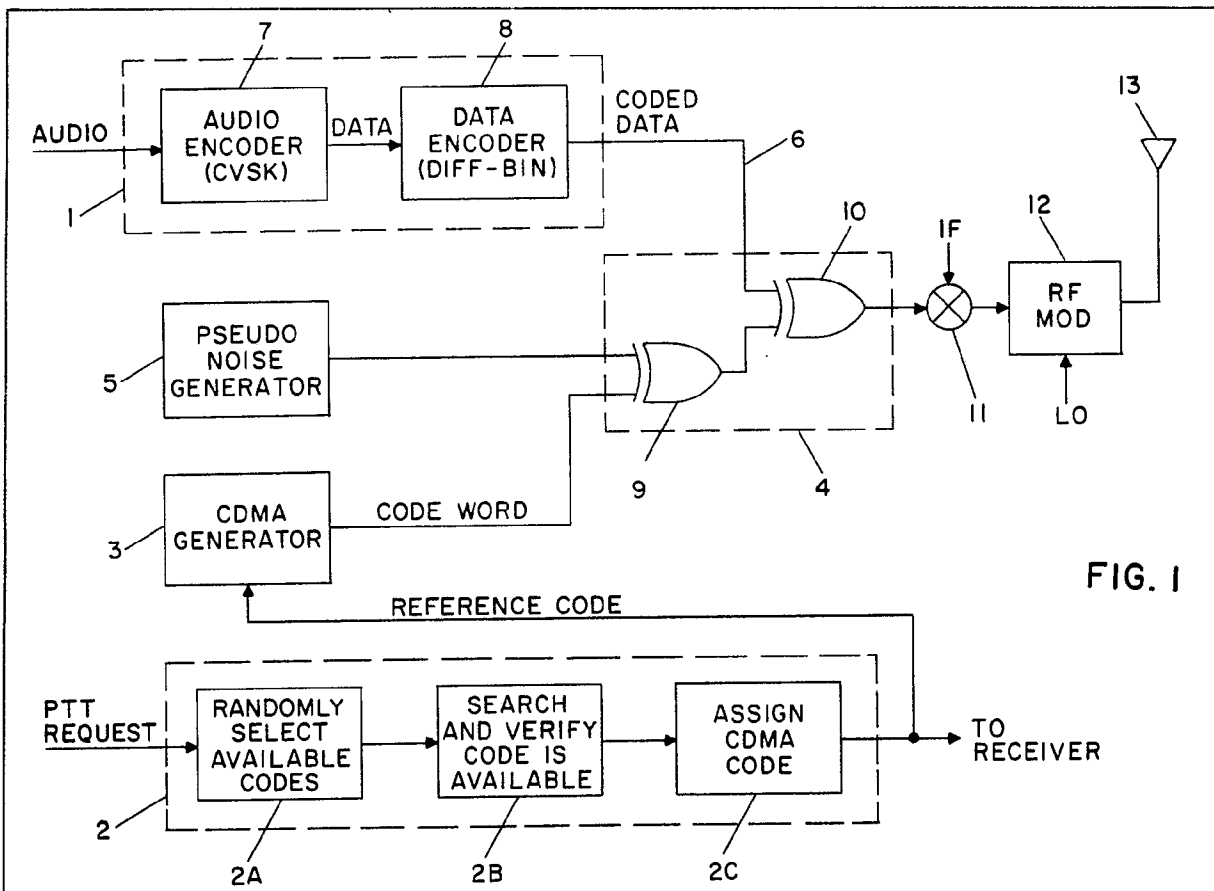**H4M**
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(54) **Intranetwork code division multiple access communication system**

(57) A CDMA format is used within a network to permit communication between members of the network. A predetermined set of digital code words is established for the network. A member desiring to transmit digital data selects an unused code word. A CDMA generator generates a reference code corresponding to the selected unused code word. The code word is gated with a signal from a pseudo-random noise generator, the output of which is then gated with the digital data to be transmitted to form a digital signal. A carrier signal is modulated with the digital signal and transmitted. The transmitted digital data modulating the carrier signal is demodulated to provide a digital signal. The particular code word embodied in the digital signal is determined by a corresponding PN generator and a corresponding CDMA generator which provides outputs which are gated and mixed with the digital signal resulting in the digital data being separated from the digital signal.
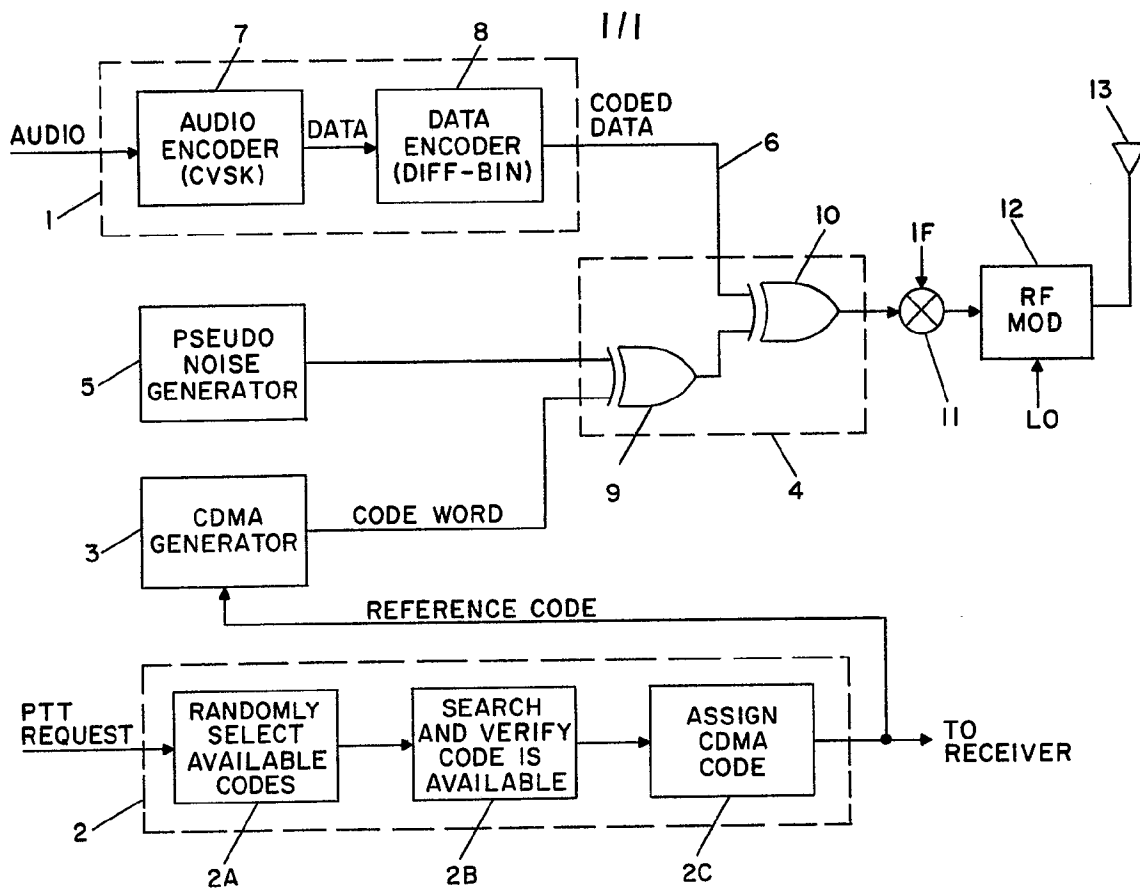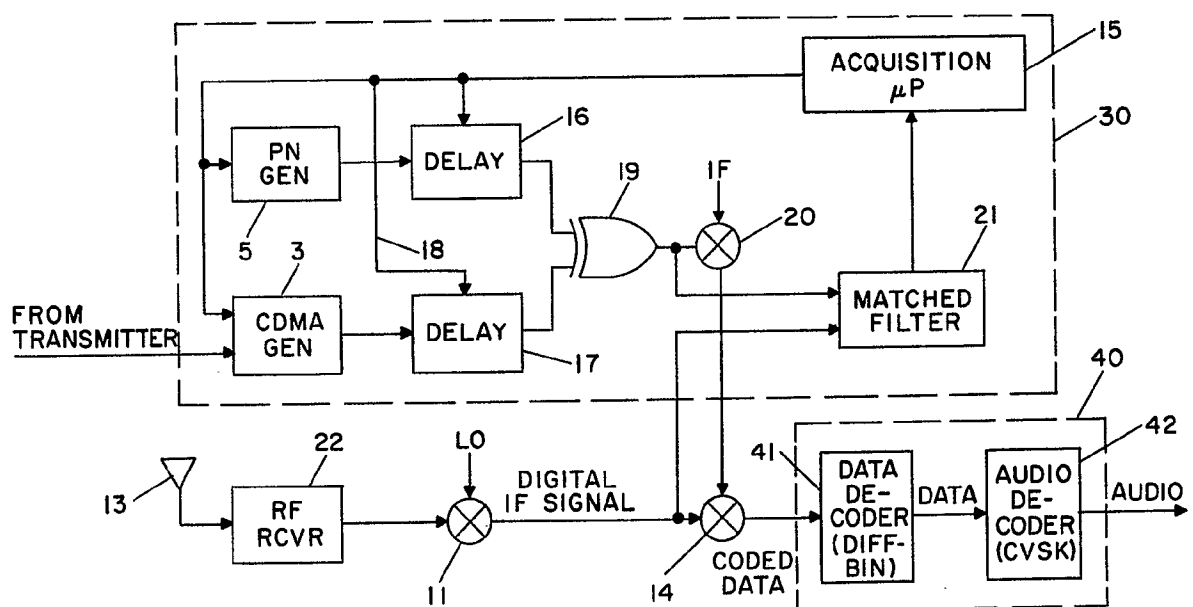
FIG. I

FIG. I

FIG. 2

SPECIFICATION

Intranetwork code division multiple access communication system

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The invention relates generally to communication systems and, in particular, to communication systems employing code division multiple access.

Code division multiple access communication
10 systems are well known in the prior art. Such systems assign codes to users according to a demand access (or floating assignment) priority or may use pre-assigned codes. In the former case, assignments of codes may be controlled or self-
15 selecting (autonomous) controlled assignments which tend to limit the system operating parameters. Self-selecting code systems require a network-controlled master to monitor the selection process. In the latter case of a multiple member network in
20 which two or three members may be simultaneously communicating, preassigning of codes becomes very complex and is a limiting factor in the number of members which can be a part of the network.

It is an object of this invention to provide a
25 communication system employing code division multiple access (CDMA) in a floating assignment or demand access mode.

It is another object of this invention to provide a CDMA communication system which self-selects
30 codes without a network-controlled master.

The invention includes an apparatus for transmitting digital data within a network. An unused code word is selected from a predetermined set of code words within the network. A reference code corres-
35 ponding to the selected unused code word is generated and the digital data to be transmitted is gated with the selected code word thereby forming a digital signal. A carrier signal is modulated with the digital signal and the modulated carrier signal is
40 transmitted.

The transmitted digital data is detected and the carrier signal is demodulated from the detected signal to provide the digital signal. The code word embodied in the digital signal is determined from
45 the available code words and the digital data is separated from the code word embodied in the digital signal.

For a better understanding of the present invention, together with other and further objects, refer-
50 ence is made to the following description, taken in conjunction with the accompanying drawings, and its scope will be pointed out in the appended claims.

Figure 1 is a block diagram illustrating a transmitter according to the invention.

55 *Figure 2* is a block diagram illustrating a receiver according to the invention.

The invention relates generally to the transmission of digital data. The digital data to be transmitted may be provided by any source and is referred to in
60 Figure 1 as coded data transmitted via line 6. As illustrated in Figure 1, the coded data on line 6 may be the result of audio information which is applied to audio encoder 7, the output of which is applied to data encoder 8. Audio encoder 7 may be any prior art
65 system for digitally encoding audio information such

as a continuously variable slope delta-modulated key (CVSK) system. The data output of audio encoder 7 may be digitally encoded by a differential binary encoder or any other digital encoder known in the
70 prior art. Audio encoder 7 and data encoder 8 form a means for providing the digital data to be transmitted as coded data 6.

In pre-assigned CDMA systems, each member of a network is normally provided with a code. However,
75 usually only a few (two or three) members are communicating at any given time and it is only necessary for codes to be assigned to those members which are communicating. When the number of members in a given network is large, preassigning
80 each member a different code becomes a complex problem since each member must be able to detect the codes of all other members of the same network. In demand access CDMA, a control or master for each network is required to monitor code assign-
85 ments. The need for a control monitor is an unnecessary limit on the system.

The present invention minimizes these problems by predetermining a set of code words which are used by a given network and permits each memeber
90 to select its own word. This set of code words is sufficiently large to avoid detection and deciphering. The actual number of code words in the set is based on the anticipated number of members which would be communicating during a given period of time and
95 the security desired. For example, when only two members are likely to be communicating within a network at any given time, twenty codes may be used to define the predetermined set.

Rather than preassigning code words to each
100 member, the invention employs floating assignment or demand access of the code words without the need for a control monitor. Each member is familiar with the set of, for example, thirty code words and continuously monitors the use of the code words
105 within the network. When a network member desires to transmit digital data, a push-to-talk (PTT) request is provided to a means for selecting an unused code word from the predetermined set of code words. Such a means may be a selector referred to by
110 reference character 2. Monitor 2B monitors the codes stored in means 2A which includes a memory and a pseudo-random generator which randomly selects the available codes for monitoring. Monitor 2B segregates all code words which are not being
115 used. An algorithm defined in processor 2C selects a code word from the unused code words which are available at a particular time and verifies through monitor 2B that the code word is available. More than one code word may be selected and searched
120 for verification depending on the algorithm being employed. When a code word is verified as available, processor 2C assigns the code word to the network member and provides a reference code to CDMA generator 3. The reference code corresponds
125 to the unused code word that has been selected and causes generator 3 to generate the particular code word. This code word is gated by gating means 4 with an output signal from pseudo-random noise generator 5, the output of which is then gated with
130 coded data 6. Gating means 4 may be any logic

gating circuitry for achieving a desired overlaying of information such as exclusive OR gates 9 and 10. The output of gating means 10 is provided to mixer 11 along with an IF signal on which the data is
5 modulated, the output of which is provided to a radio frequency modulator 12 which modulates a local oscillator carrier signal with the information provided at the output of mixer 11. The modulated carrier is then transmitted by antenna 13.
10 Figure 2 illustrates a receiver according to the invention. Similar reference characters are used for similar structure. In a receiver/transmitter unit used by a member of the network, such similar structure may be a single item which functions in both the
15 transmit and receive modes. As shown in Figure 2, RF receiver 22 receives the information on the carrier signal received by antenna 13. The received information is applied to mixer 11 along with the local oscillator carrier signal LO to provide an IF signal
20 including a digital signal. This is applied to mixer 14 along with the output from means 30 for determining, from the available code words, the code word which is embodied in the digital signal. The output of mixer 14 provides coded data to means 40 for
25 separating and decoding the digital data from the code word embodied in the digital signal. Data decoder 41 determines the data within the coded data signal and provides the data to audio decoder 41 for providing the audio signal from data.
30 Means 30 includes acquisition microprocessor 15 which is used to control CDMA generator 3 and delays 16 and 17. Means 2 provides a signal to CDMA generator 3 which represents one of the available codes at a particular point in time. Proces-
35 sor 15 gates this code with PN generator output 18 through exclusive OR gate 19. The output of OR gate 19 is provided to matched filter 21 along with the output of mixer 11. Matched filter 21 is a programmable matched filter which is controlled by processor
40 15 to be matched to each of the codes of the predetermined set of code words. When the code word in the message is matched to filter 21, processor 15 instructs generator 3 to duplicate this code word. The delayed PN generator output 18 and
45 CDMA generator output are suitably delayed and gated by gate 19 and mixed with the IF signal by mixer 20. The output of mixer 20 is then mixed with the digital IF signal by mixer 14. This results in mixer 14 providing coded data to decoders 41 and 42.
50 CLAIMS

1. An apparatus for transmitting digital data within a network comprising:
55 first means (1) for providing the digital data to be transmitted;
second means (2) for selecting, from a predetermined set of code words within the network, an unused code word;
60 third means (3) for generating a reference code corresponding to the unused code word selected by the second means;
fourth means (4) for gating the digital data and a particular code word corresponding to said refer-
65 ence code to form a digital signal;

fifth means (11) for modulating a carrier signal with the digital signal; and
sixth means (12) for transmitting the modulated carrier signal.
70 2. The apparatus of claim 1 further comprising a pseudo-random noise (PN) generator (5) supplying a PN signal and wherein said fourth means gates the PN signal with the digital data and the reference code to form a digital signal.
75 3. The apparatus of claim 2 wherein said first means comprises an audio encoding means having an input for receiving the audio information and having an output for providing digital data corresponding to said audio information.
80 4. The apparatus of claim 3 wherein said first means further comprises a data encoder with an input for receiving the digital data and an output for providing coded digital data corresponding to the digital data.
85 5. The apparatus of claim 1 wherein said second means comprises means for randomly selecting available codes, means for searching and verifying that the selected codes are available and means for assigning a code division multiple access (CDMA)
90 code.
6. The apparatus of claim 5 wherein said third means comprises a CDMA generator.
7. The apparatus of claim 6 wherein said fourth means comprises at least one exclusive OR gate.
95 8. The apparatus of claim 7 wherein said fifth means and said sixth means comprise an RF modulator and transmitter.
9. An apparatus for receiving a signal comprising a particular code word and digital data modulating a
100 carrier signal comprising:
first means (13) for detecting the signal;
second means (22, 11) for demodulating the carrier signal from the detected signal and for providing a digital signal including the particular
105 code word and the digital data;
third means (2) for determining, from a predetermined set of code words, the available code words;
fourth means (30) for determining, from the available code words, the particular code word
110 included in the digital signal; and
fifth means (40) for separating the digital data from the particular code word included in the digital signal.
10. The apparatus of claim 9 wherein said fourth
115 means comprises a pseudo-random noise (PN) generator supplying a PN signal;
a CDMA generator for generating a reference code corresponding to one of the unused codes;
means for gating the PN signal and the reference
120 code to form a digital reference signal; and
means for mixing the digital reference signal and the digital signal and providing the transmitted digital data.
11. An apparatus comprising:
125 a transmitter comprising first means for providing digital data to be transmitted within a network;
second means for selecting, from a predetermined set of code words within the network, an unused code word;
130 third means for generating a reference code

corresponding to the unused code word selected by
the second means;
      fourth means for gating the digital data and a
particular code word corresponding to said refer-
5 ence code to form a digital signal;
      fifth means for modulating a carrier signal with the
digital signal; and
      sixth means for transmitting the modulated carrier
signal;
10   and a receiver comprising seventh means for
detecting the modulated carrier signal;
      eighth means for demodulating the carrier signal
from the detected modulated carrier signal and for
providing a digital signal including the particlar code
15 word and the digital data modulating the carrier
signal;
      ninth means for determining, from a predeter-
mined set of code words, the available code words;
      tenth means for determining, from the available
20 code words, a code word embodied in the digital
signal; and
      eleventh means for separating the digital data
from the code word embodied in the digital signal.
      12.   Apparatus according to claim 1 and substan-
25 tially as described herein with reference to Figure 1
of the accompanying drawing.
      13.   Apparatus according to claim 9 and substan-
tially as described herein with reference to Figure 2
of the accompanying drawing.
30   14.   An intranetwork code division multiple ac-
cess communication system substantially as de-
scribed herein with reference to the accompanying
drawing.